

LPGS Critical Design Review



■ Opening Comments	J. Henegar
■ System Overview	R. Hamilton
■ Hardware Architecture	K. Jeletic
■ Operational Scenarios	K. Jeletic
■ Level 1 Product Formats	L. Lindrose
■ Performance Analysis	W. Wang
■ LPGS Software Subsystem Design	
• Design Overview	B. Pedersen
• End-to-End Scenarios	B. Pedersen
• User Interface	O. Mechaly
• Data Management Subsystem	S. Beckwell
• Process Control Subsystem	B. Pedersen
• Radiometric and Geometric Processing Subsystems	B. Pedersen
• Quality Assessment Subsystem	S. Kraft
• Anomaly Analysis Subsystem	B. Nair
■ System Test	E. Crook
■ Conclusion	J. Henegar

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Closing Remarks

- Open issues/assumptions review
- LPGS release plan
- Size estimates
- Schedule



Open Issues/Assumptions

- **Network connectivity to IAS**
 - Assume final network connection to IAS will support interface as designed
 - If connectivity does not support designed interface, interface with IAS will need to be reworked
 - Awaiting ECS recommendations on network connectivity
- **Color printer**
 - Assume color printer is available through EDC DAAC institutional equipment
 - If LPGS must provide printer, cost will need to be added to LPGS budget
- **COTS product for generation of FAST-C formats**
 - Assume COTS product will be available
 - If COTS product is not available by Release 2 implementation, development of custom software to provide this requirement will need to be investigated



■ **Release 1**

4/20/98

- **Ingest data from ECS**
- **Convert product requests to work orders**
- **Automatic scheduling of work order processing**
- **Automatic quality assessment**
- **Invoking radiometry and geometry processing**
- **Produce and deliver L1R products**
- **Produce and deliver L1G products (HDF and GeoTIFF)**
- **Minimal operator/analyst interface**
- **Some data set display and analysis capabilities**

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LPGS Release Plan (Cont'd)



■ Release 2 (full functionality)

7/20/98

- Manual override options
- Full process control and data management
- Full quality assessment
- Remaining LPGS external interfaces (IAS)
- Full user interface capabilities
- Produce L1G FAST-C product
- Trouble ticket interface

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LPGS Release Plan (Cont'd)



Subsystem	Release 1	Release 2
Process control	Start up LPGS	Support manual overrides
	Automatically schedule work order	Support non-nominal processing
	Automatically process work order	Generate LPGS processing statistics
Data management	Ingest L0R products from ECS	Manage disk space
	Quality assess L0R products; generate consensus PCD and MSCD	Interface with IAS
	Generate L1 product in HDF-EOS and GeoTIFF formats	Generate L1 product in FAST-C format
	Provide L1 products to ECS	Record ECS interface statistics
Quality assessment	Provide automatic quality assessment of image immediately following radiometric and geometric processing	Visually assess image immediately following radiometric and geometric processing
		Visually assess formatted, L1 product

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LPGS Release Plan (Cont'd)



Subsystem	Release 1	Release 2
Anomaly analysis	Provide tools for examining contents of input, intermediate, and output files	Perform anomaly analysis of trouble tickets
User interface	Provide partial operator and analyst interface	Provide operator and analyst interface
Radiometric processing	Detect L0R image artifacts (striping, banding, coherent noise, scan correlated shift, saturated detectors, dropped scan lines)	
	Characterize L1R image (striping, banding, coherent noise, saturated detectors, dropped scan lines)	

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LPGS Release Plan (Cont'd)



Subsystem	Release 1	Release 2
Radiometric processing (Cont'd)	Correct L1R image (striping, banding, coherent noise, memory effect, scan correlated shift, inoperable detectors, saturated detectors, dropped scan lines)	
	Generate L1R image (apply radiometric correction)	
Geometric processing	Generate L1G image (create and initialize model, generate systematic grid, resample and create systematic image)	

LPGS Critical Design Review**Sizing**

Subsystem	Est LOC	R1	R2
User interface (UI)	8000	2600	5400
Process control subsystem (PCS)	2700	2100	600
Data management subsystem (DMS)	12130	9290	2840
Quality assessment subsystem (QAS)	2400	1800	600
Anomaly analysis subsystem (AAS)	2500	1500	1000
Radiometric processing subsystem (RPS)	24000	24000	-
Geometric processing subsystem (GPS)	39000	39000	-
Globals	4895	4570	325
Database	10235	9860	375
Diagnostic and test	3500	2900	600
Grand total	109360	97620	11740

LPGS Critical Design Review**Reuse Summary**

Subsystem	R1		R2	
	New	Reuse	New	Reuse
User interface (UI)	2600	-	3400	2000
Process control subsystem (PCS)	1400	700	600	-
Data management subsystem (DMS)	4890	4400	2340	500
Quality assessment subsystem (QAS)	1800	-	600	-
Anomaly analysis subsystem (AAS)	500	1000	500	500
Radiometric processing subsystem (RPS)*	-	24000	-	-
Geometric processing subsystem (GPS)*	-	39000	-	-
Globals	20	4550	325	-
Database	3960	5900	325	50
Diagnostic and test	900	2000	600	0
Total	16070	81550	8690	3050
Total per release	97620		11740	
Grand total	109360			

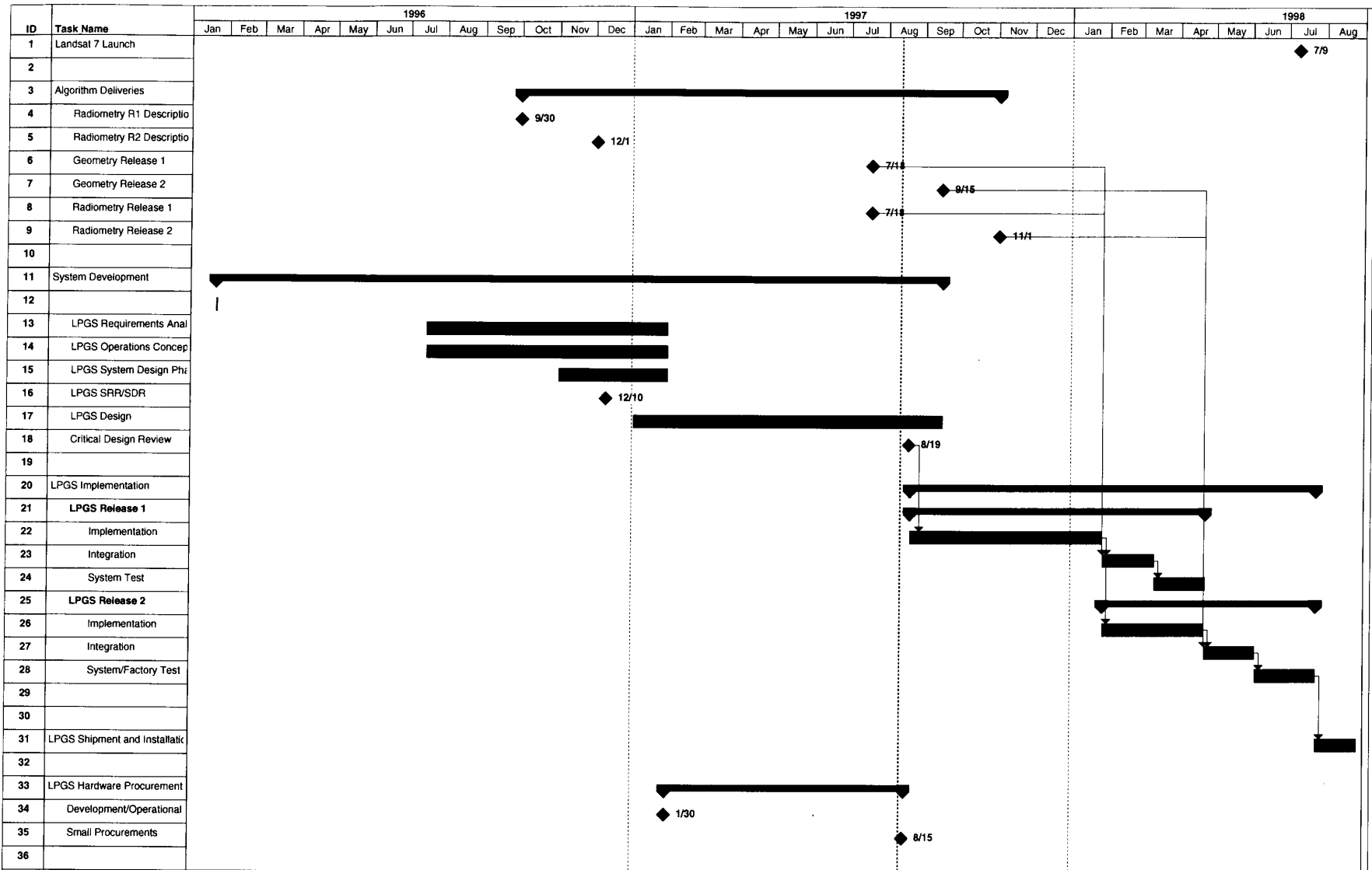
*RPS and GPS are black boxes to LPGS. Software development only has to integrate the subsystems into LPGS.

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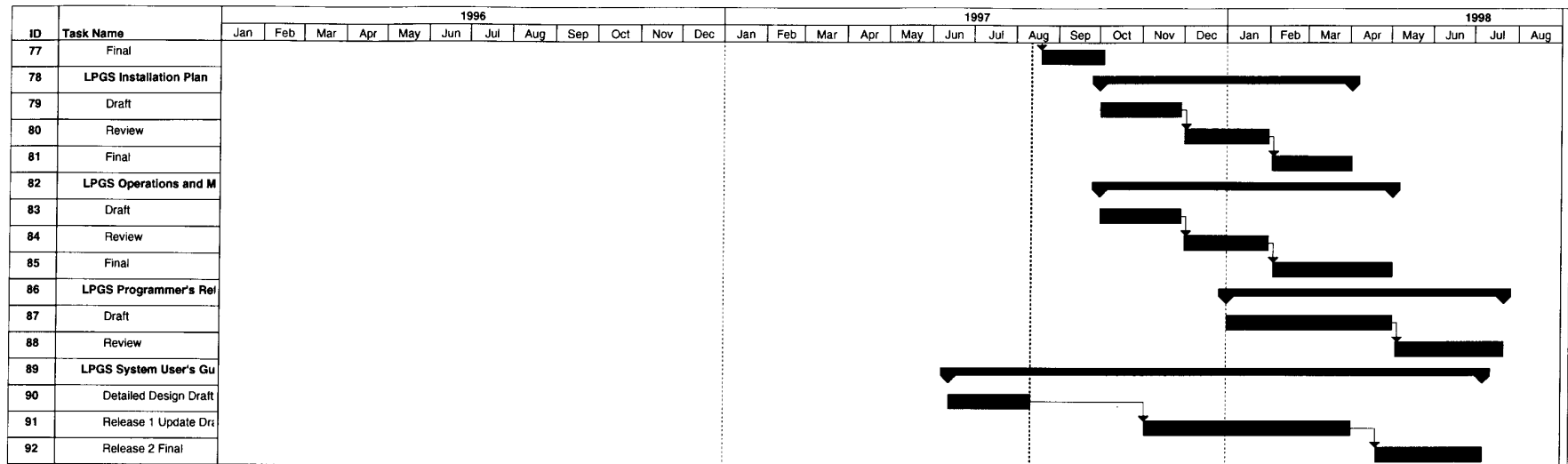


Schedule



Project:
Date: Tue 8/12/97

Task [Bar] Milestone ◆
Progress [Bar] Summary [Bar] Rolled Up Task [Bar] Rolled Up Progress [Bar]
Rolled Up Milestone ◇



Project:
Date: Tue 8/12/97

Task
Progress

Milestone
Summary



Rolled Up Task
Rolled Up Milestone

Rolled Up Progress



- **Submit RIDs to Joy Henegar no later than September 5, 1997**
 - **Submit RIDs by e-mail (preferred method):**
joy.henegar@gsfc.nasa.gov
or by hardcopy (RID form provided):
J. Henegar
Code 514
 - **For an e-mail submission, make sure all required information is provided (see RID hardcopy form)**
- **Items against which RIDs may be written**
 - **Presentation package**
 - **LPGS accompanying documentation**

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REVIEW SUBJECT:	CONFIGURATION CONTROL BOARD		NUMBER (FOR CODE 514 CCB USE ONLY)
DATE OF REVIEW:	REVIEW ITEM DISPOSITION		
ORIGINATOR:	ORGANIZATION:	EXTENSION:	
SUBJECT OF COMMENT:			
DOCUMENT TITLE/NUMBER:			
DESCRIPTION OF PROBLEM:			
ORIGINATOR'S RECOMMENDATION:			
IMPACT IF RECOMMENDATION NOT ACCEPTED:			
ACTIONEE'S RESPONSE:			
NAME OF ACTIONEE:	SIGNATURE:	DATE:	
DISPOSITION			
<input type="checkbox"/> APPROVED AS WRITTEN <input type="checkbox"/> APPROVED WITH MODIFICATIONS <input type="checkbox"/> DISAPPROVED			
REVIEW BOARD CHAIRMAN:		DATE:	

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KEY TERMS



Key Terms

- **External element**—Data that are stored in a separate file, external to the basic HDF file. External elements allow for products to be read without using the HDF library
- **Interval**—The time duration between the start and stop of an imaging operation (observation) of the Landsat 7 ETM+ instrument
- **Level 0R (L0R) digital image**—Spatially reformatted, demultiplexed, and unrectified subinterval data



Key Terms (Cont'd)

- **Level 0R (L0R) product—L0R digital image plus radiometric calibration, attitude, and ephemeris data in HDF-EOS unencapsulated format. The L0R product consists of the following files:**
 - **L0R digital image**
 - **IC data—Calibration data file containing all the calibration data received on a major frame basis for a given subinterval**
 - **MSCD—Scan direction and error information for a given subinterval**
 - **PCD—Information on spacecraft attitude and ephemeris, including quality indicators for each subinterval**
 - **Metadata—Descriptive information about the L0 digital image, names of appended files associated with the image, and quality and accounting information**
 - **CPF—Formatted file containing gains, biases, and offsets for the instrument and detectors**



Key Terms (Cont'd)

- **Level 1R (L1R) digital image—Radiometrically corrected, but not geometrically resampled**
- **Level 1R (L1R) product—L1 product packaged by the LPGS and distributed by the ECS to the customer and consisting of the following in HDF format:**
 - **L1R digital image**
 - **IC data—Calibration data file containing all the calibration data received on a major frame basis for a given subinterval**
 - **Consensus MSCD—Scan direction and error information for a given subinterval**
 - **Consensus PCD—Information on spacecraft attitude and ephemeris, including quality indicators for each subinterval**
 - **Metadata—Descriptive information about the L1 digital image, names of appended files associated with the image, and accounting information**



Key Terms (Cont'd)

- **CPF—Formatted file containing gains, biases, and offsets for the instrument and detectors**
- **Geolocation table—Scene corner coordinates and scan line numbers**
- **Level 1G (L1G) digital image—Radiometrically corrected and resampled for geometric correction and registration to geographic map projections**
- **Level 1G (L1G) product—L1 product packaged by the LPGS and distributed to the customer by the ECS; consists of, for all requested bands, FAST-C or GeoTIFF format L1G image and associated data accommodated by the format; HDF format L1G image; and metadata**



- **Procedure**—Template used to create work orders. It includes an ordered list of work order scripts and the default parameters associated with each script
- **Product generation request**—Request received from ECS directing LPGS to generate a specific L1R or L1G product. The product generation request includes
 - L0R subinterval identifier
 - Start and stop scan lines
 - Output product (L1R or L1G)
 - Output format
 - Band selection
 - Map projection option and project parameters
 - Grid cell size
 - Resampling filter



- **Orientation**
- **Calibration method**
- **Scientific data set (SDS)**—Array of data of any fixed dimensionality from 1 to 32767 and any one data type
- **Subinterval**—Segment of time corresponding to a portion of an observation within a single Landsat 7 contact period
- **Vdata**—Record-based structure where values are stored in fixed-length fields. Fields are defined, named, and typed individually. All records within a Vdata are identical in structure
- **Vgroup**—Structure for associating sets of data objects. Vgroups define logical relationships and may contain any HDF objects, including other Vgroups



- **Work order**—Detailed instructions for the L1 processing of a specific product generation request. A work order is constructed from an ordered list of work order scripts. It also encompasses the parameters associated with each script
- **Work order script**—A UNIX script used to run one or more programs as a part of a work order
- **Worldwide Reference System (WRS) scene**—Digital image that covers an area equivalent to 1 of the 57,784 scene-centers (233 paths x 248 rows areas) defined by the WRS structure

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LPGS Critical Design Review



GLOSSARY



Glossary

AA	anomaly analysis	CPU	central processing unit
AAS	Anomaly Analysis Subsystem	DAA	data availability acknowledgment
ADS	attitude displacement sensor	DAAC	Distributed Active Archive Center
API	applications programming interface	DAN	data availability notice
AR	acquire request	DAT	digital audio tape
ARA	AR acknowledgment	DB	database
ASCII	American Standard Code for Information Interchange	DBA	database administrator
CASE	computer-aided software engineering	DBMS	Database Management System
CC	cubic convolution	DD	data dictionary
CCR	configuration change request	DDA	data delivery acknowledgment
CD	compact disc	DDE	data dictionary entry
CDAS	Command and Data Acquisition System	DDN	data delivery notice
CD-ROM	CD read-only memory	DFCB	data format control book
CI	configuration item	DFD	data flow diagram
CNMOS	Consolidated Network and Mission Operations Support	DFL	DMS Format L1 Product task
COTS	commercial off-the-shelf	DGR	DMS Generate Reports task
CPF	calibration parameter file	DHF	Data Handling Facility
		DIE	DMS Interface with ECS task
		DIL	DMS Ingest L0R Product task
		DMS	Data Management Subsystem

LPGS Critical Design Review**Glossary (Cont'd)**

DPL	DMS Process LOR Product task	FDDI	fiber distributed data interface
DRM	DMS Resource Manager task	FHSERR	first half scan error
DXL	DMS Xmit (i.e., Transmit) L1 Product task	FIFO	first in, first out
ECS	EOSDIS Core System	ftp	file transfer protocol
EDC	EROS Data Center	GB	gigabyte
EGS	EOS Ground System	GByte	gigabyte
EOS	Earth Observing System	GCP	ground control point
EOSAT	Earth Observation Satellite Company	GDS	ground data system
EOSDIS	EOS Data and Information System	GeoTIFF	Geographic Tag(ged) Image File Format (an output format for L1 digital images)
EROS	Earth Resources Observation System	GPS	Geometric Processing Subsystem
ESDIS	Earth Science Data and Information System	GSFC	Goddard Space Flight Center
ETM+	Enhanced Thematic Mapper Plus	GUI	graphical user interface
F&PRS	functional and performance requirements specification	HDF	Hierarchical Data Format
FAST	Fast Argonne System for Transport (an output format for L1 digital images)	HWC	hardware component
		HWCI	hardware configuration item
		IF	interface
		I/F	interface
		I/O	input/output

LPGS Critical Design Review**Glossary (Cont'd)**

IAS	Image Assessment System	MB	megabyte
IC	internal calibrator	Mbps	megabits per second
ICD	interface control document	MBps	megabytes per second
IDD	interface definitions document	MFLOPS	million floating point operations per second
IDL	Interactive Development Language	MHz	megahertz
IGS	International Ground Station	mm	millimeter
IP	Internet Protocol	MMO	Mission Management Office
ISO	International Standards Organization	MO&DSD	Mission Operations and Data Systems Directorate
L0R	Level 0R	MO&SDD	Mission Operations and Systems Development Division
L1	Level 1	MOC	Mission Operations Center
L1G	Level 1G	MS	Microsoft
L1R	Level 1R	MSCD	mirror scan correction data
L7	Landsat 7	msg	message
LAN	local area network	MTF	modulation transfer function
Landsat	Land Satellite	MTPE	Mission to Planet Earth
LGN	Landsat Ground Network	MTTR	mean time to restore
LGS	Landsat 7 Ground Station	NASA	National Aeronautics and Space Administration
LPGS	Level 1 Product Generation System		
LPS	Landsat 7 Processing System		
M	meter		

LPGS Critical Design Review**Glossary (Cont'd)**

NCC	Network Control Center	PDL	Program Design Language
NCEP	National Centers for Environmental Prediction	PDR	product delivery record
NCSA	National Center for Supercomputing Applications	PR	product request
NFS	Network File System	PSI	PCS System Initialization/ Termination task
NN	nearest neighbor	PSO	Project Science Office
NOAA	National Oceanic and Atmospheric Administration	PWC	PCS Work Order Controller task
02	SGI 02 workstation	PWG	PCS Work Order Generator task
O/H	overhead	PWS	PCS Work Order Scheduler task
O2000	SGI Origin 2000 server	Q1G	QAS Automated L1G Quality Assessment task
ODL	Object Descriptive Language	Q1R	QAS Automated L1R Quality Assessment task
OMA	Oblique Mercator Type A	QA	quality assessment
Opr	operator	QAS	quality assessment subsystem
PAN	product acceptance notification	QASE	quantitative CASE tool
PC	personal computer	QC	quality check
PCD	payload correction data	QUI	QAS Visual Quality Assessment User Interface task
PCMB	Project Configuration Management Board	RAID	redundant array of inexpensive devices
PCS	process control subsystem		

LPGS Critical Design Review



Glossary (Cont'd)

RAM	random access memory	SN	Space Network
RID	review item disposition	SNR	signal-to-noise ratio
RMA	reliability, maintainability, and availability	SOCC	Satellite Operations Control Center
RPC	remote procedure call	SOM	Space Oblique Mercator
RPS	radiometric processing subsystem	SQL	Structured Query Language
RSI	Research Systems, Inc.	SRR	system requirements review
R/T	real time	SWCI	software configuration item
RTM	Requirements and Traceability Management (tool)	TBD	to be determined
SAT	shift along track	TCP	Transmission Control Protocol
SCSI	small computer system interface	TDRS	Tracking and Data Relay Satellite
SDPS	science data processing segment	TIFF	tagged image file format
SDR	system design review	TT	trouble ticket
SDS	system design specification	UI	user interface
SDS	scientific data set	URF	user request file
SEAS	Systems, Engineering, and Analysis Support	USGS	United States Geological Survey
SGI	Silicon Graphics, Inc.	UTM	Universal Transverse Mercator
SHSERR	second half scan error	W/S	workstation
		WO	work order
		WRS	Worldwide Reference System